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(19)(CA) **APPLICATION FOR CANADIAN PATENT** (12)

(54) Method for Delivering Pulp Onto the Wire of a Paper Machine

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(57) ABSTRACT OF THE DISCLOSURE

The invention concerns a method for delivering pulp onto the wire of a paper machine into a sheet which in the later stages in converted into finished paper. The thick pulp from the pulping process is suspended with the white water recirculated in the paper machine into a suspension, which is delivered onto the wire into a homogeneous sheet and from which the water drained through the wire is recirculated to the suspension process. The closed circulation allows the enrichment of constituents such as hemicellulose dissolved or dispersed from the stock being prepared that lower water drainage and degrade the retention of fibers. According to the invention, enzymes are added to the lean white water of low consistency that are capable of disintegrating said deleterious constituents. The enzyme can be added to the short circulation of lean white water taking place from the sheet forming on the wire to the suspension process of the pulp, or alternatively, to the long circulation of the white water to other locations of use in the paper machine. The invention is particularly applicable to papermaking based on mechanical pulp such as TMP in which the amount of hemicellulose dissolving in the white water is highest.

METHOD FOR DELIVERING PULP ONTO THE WIRE OF A PAPER MACHINE

The present invention concerns a method for delivering pulp onto the wire of a paper machine, in which method pulp is suspended into the white water into the form of a suspension which is delivered onto the wire and in which method the white water drained from the formed sheet through the wire is returned to the suspension process.

An essential step in the papermaking process is the sheet-forming process, which takes place by diluting the thick pulp from pulp production into a low-consistency suspension and pumping this suspension via centrifugal cleaners and deaeration to the headbox of the paper machine and therefrom further onto a water-permeable wire, onto which a homogeneous sheet is formed at the drainage of water. The formed sheet is processed in the subsequent processing stages into a finished paper.

The economics of papermaking presumes maximum retention, which means that fibers carried along the suspension should be retained as effectively as possible in the sheet being formed onto the wire. For this purpose, the water circulation of the process is closed by recirculating the white water drained from the sheet through the wire back to the stock preparation phase, whereby the fibers are repetitively offered an opportunity to adhere to the forming sheet. Furthermore, a closed water circulation is important in the reduction of waste water effluents.

A problem of the closed water circulation in papermaking is, however, that a continuously growing concentration of

constituents dissolved or dispersed from the stock being prepared develops into the recirculated white water. These constituents disturb the papermaking by deteriorating retention, preventing the effect of additives, causing accumulations in the process machinery and occurring as transferred impurities in the paper being produced. A major portion of the matter dissolved into the white water is composed of carbohydrates, in particular of hemicellulose having a molecular weight of approx. 10 000 ... 100 000. In addition, the white water contains dissolved lignin and extracted constituents that due to their lower solubility and higher adsorption capability seek to precipitate on the fibers, thereby avoiding enrichment into the white water in the same manner as carbohydrates tend to do.

The present invention aims to provide a method capable of reducing the above-described problems in papermaking which arise from the closed water circulation. The invention is characterized in that an enzyme is added to the white water in order to disintegrate constituents such as hemicellulose dissolved or dispersed from the pulp.

When the substances dissolved or dispersed into the white water are advantageously disintegrated in accordance with the invention into smaller fragments, water drainage from the forming sheet on the wire is improved. In addition, disintegration of hemicellulose has been shown to promote the retention of fibers. Without any limitation on the scope of this invention, the reason for this phenomenon is assumed to be caused in that hemicellulose, which by its adherence to fibers gives them an anionic characteristic thus causing their mutual rejection, loses its adsorbing capability during disintegration, whereby the fibers can

retain their neutral nature, thus improving their retention in the sheet.

In relation to the subject is recognized a prior art method disclosed in FI patent application 874113 aiming at improvement in water drainage from the forming sheet by means of enzymes. This method, however, relates to the addition of enzymes into the high-consistency pulp so that the enzymes effect the fibers prior to the resuspension of the thick pulp into a suspension to be delivered onto the wire. By contrast, the present invention as described above concerns the addition of enzymes into the white-water system so that they are used in the white water for the disintegration of dissolved or dispersed constituents, particularly dissolved hemicellulose.

The enzymes applicable in the method are hemicellulase, cellulase, esterase and pectinase as well as their combined mixtures. Cellulase for instance with a CMC activity of 5000 U/ml or β-xylosidase with an activity of 2000 nkat/ml are suitable. The enzyme can be metered by 0.01...1 l/m^3 white water using a preferred metering method in which the pure enzyme is first diluted into a smaller quantity of water, in which it is then metered into the white water. For the functioning of the enzyme, water temperature must be 10...90 °C, preferably 40...70 °C, while the pH must be 3.0...8.5, preferably 4.0...6.0.

According to the method, the enzyme is primarily added to the short circulation of rich white water in which white water is recirculated from the sheet formation on the wire back to the dilution of incoming stock. The problems

caused by constituents dissolved in the white water are typically evident in this area. Since the fiber consistency in the rich white water can be assumed low, typically approx. 0.4 % maximum, the enzyme has the opportunity to attack the dissolved substances in the white water effectively without interference from fibers, therein purporting the actual objective of the invention. A suitable location of enzyme addition is the wire pit, into which white water drained from the sheet is routed for mixing into the high-consistency pulp to be diluted.

According to the method, it is also possible to apply the enzyme addition to the so-called long circulation of lean white water in which white water drained from the sheet is recirculated for reuse at locations situated closer to the start end of the papermaking process. A suitable location of enzyme addition here is for instance the couch pit, which acts as a collecting well for the white water drained from the sheet by suction. A portion of the suction box white water can be routed from the couch pit along with the short circulation to the wire well, while the rest is added to the above-described long circulation of lean white water. A particular advantage of this application is that the white water entering the couch pit has an appropriately lower consistency than that of the white water entering the wire well.

The maximum benefit of the invention is achievable in applications to papermaking using groundwood pulp such as TMP or CTMP. This is because the amount of deleterious substances dissolving or dispersing into the white water from the groundwood is particularly high. Nevertheless, an advantageous result from the use of enzyme addition in

accordance with the invention is also achieved in papermaking from chemical pulp.

Furthermore, the invention concerns the use of enzymes in the disintegration of organic matter dissolved or dispersed from the pulp into the white water of the paper machine. In accordance with the above description the preferred enzymes are hemicellulase, cellulase, esterase, pectinase as well as their combined mixtures.

The invention is described in detail in the following with the help of the enclosed drawing which diagrammatically illustrates a sheet forming process in accordance with the invention and in which the short circulation of the rich white water is shown as a whole.

As shown in the drawing, the thick stock received from pulp preparation with a fiber consistency of approx. 5 % is pumped via a line 1 to the bottom of a wire well 2, where it is mixed with the white water. The obtained suspension is routed via a fan pump 3 to a centrifugal cleaner 4, whose accept fraction continues to a deaeration chest 5. The reject fraction of the centrifugal cleaner 4 continues to the next centrifugal cleaner units 6, of which only one is illustrated, while the number of the units may in practice be higher in a so-called cascade connection. The collective accept fraction from these cleaners returns via a line 7 to the wire well 2 while the reject fraction from the last cleaner unit is removed from the process along a line 8. The cleaned pulp suspension from the deaeration chest 5 is pumped by a feed pump 9 to paper machine headbox 10, whose slice delivers the pulp onto a continuously circulating endless wire 11 thus

forming a homogeneous sheet on the wire. A major portion of the white water contained in the pulp is drained through the wire 11 at the horizontal section of the wire following the headbox 10, and this white water fraction is collected along a line 12 directly into a wire well 2. Arranged after the above-described wire section against the wire 11 is a top wire 13, whose drained white water is routed to the wire well 2, as well as suction boxes 14, whose drained white water is routed along a line 15 to a couch pit 16. Part of the white water in this latter pit is pumped along with the short circulation of rich white water as required to complement the white water of the wire well 2 in pulp suspension, while the rest is routed along a line 17 to the so-called long circulation of the lean white water in the paper machine.

The essential characteristic of the invention is the enzyme addition to the white water so that the enzyme-induced disintegration of dissolved and dispersed substances in the white water promotes water drainage from the sheet formed on the wire 11 and improves the retention of fibers in the sheet and, above all, prevents the influence of substances deleterious to the retention of fibers. According to the invention, the enzyme can be added to the above-described short circulation of rich white water, whereby the recirculation line 18 can be connected to the wire well 2 as shown in the figure. Instead of or complementing this arrangement, the couch pit 16 can be provided with an enzyme feed line 19, whereby enzyme-treated white water is available in the flows exiting the pit to the short circulation as well as the long circulation of the paper machine.

The effect of enzyme addition on sheet forming and achieved paper characteristics has been investigated in tests which are described in the following examples.

Example 1

Hemicellulase enzyme with an activity of 2000 IU/ml was added to a 1200 ml sample of rich white water of the short circulation and to a 1200 ml sample of lean white water of the long circulation. The enzyme was metered in doses of 0 µl (reference test), 3 µl and 30 µl per liter of white water. The water pH was approx. 5.0 and temperature 50 °C, and in each sample the enzyme was allowed to function for 3 hours with intermittent mixing. After the enzyme reaction, a pulp volume 300 ml of untreated TMP was mixed to each white water sample, and the obtained suspensions were immediately subjected to freeness measurements (according to Scan M 4:65) characterizing the water drainage of the pulp as well as anion concentration measurements (according to Neimo, in KCL circular no. 18, 1983). The results are shown in Table 1 below.

Table 1

Water circ.	Enzyme dosing (µl/l)	Freeness (ml)	Anion conc. (mekv/l)
Lean white w.	0	49	0.418
	3	55	0.037
	30	57	0.032
Rich white w.	0	40	0.133
	3	40	0.070
	30	49	0

The TMP mixed with the rich white water samples from the short circulation was formed into sheets according to Scan M 45:76 (100 g/m²). The sheets were tested according to Scan M 8:76 instructions. The results are shown below in Table 2.

Table 2

Enzyme dosing (µl/l)	Sheet basis w. (g/m²)	Porosity GH (s/100 ml)	Tensile strength (Nm/g)	Elongation (%)	Tear factor (Nm²/kg)
0	99.1	287	36.3	2.31	6.16
0.3	101.0	345	37.4	2.33	5.54
3	102.9	306	36.7	2.18	5.78

The results in Table 1 show that enzyme treatment of rich and lean white water in the short and long circulation respectively achieves an increase in freeness indicating an improved water drainage and a significant reduction in anion concentration, which is indicative of improved fiber retention and savings in the use of retention improvers. Further evidenced in Table 2 is that the enzyme treatment does not deteriorate strength properties of the paper produced from pulp samples.

Example 2

Hemicellulase enzyme in accordance with Example 1 was added in concentrations 0, 0.3 and 3 µl/l to a 1800 ml sample of rich white water of the short circulation. The water pH was approx. 5.0 and temperature 50 °C, and in

each sample the enzyme was allowed to function for 3 hours with intermittent mixing.

After the enzyme reaction, a pulp volume 300 ml of untreated TMP was mixed to each white water sample, and the obtained suspensions were immediately subjected to fiber retention measurements using the DDJ apparatus. The results are shown in Table 3 below.

Table 3

Enzyme dosing (µl/l)	Retention (%)
0	84.3
3	88.6
30	85.9

The results show retention improvement by the enzyme treatment.

For those versed in the art it is obvious that the different implementations of the invention are not exhausted by those described in the above but instead, can be varied within the scope of the disclosed claims.

THE EMBODIMENTS OF THE INVENTION IN WHICH AN EXCLUSIVE PROPERTY OR PRIVILEGE IS CLAIMED ARE DEFINED AS FOLLOWS:

1. A method for delivering pulp onto the wire (11) of a paper machine, in which method the pulp is suspended into the white water into a suspension that is delivered onto the wire and in which method the white water drained from the forming sheet through the wire is returned to the suspension process, c h a r a c t e r i z e d in that an enzyme is added to the white water in order to disintegrate constituents such as hemicellulose dissolved or dispersed from the pulp.

2. A method as claimed in claim 1, c h a r a c t e r i z e d in that the enzyme is added to the short circulation of the paper machine in which the white water is recirculated from the sheet forming stage to the suspension process of pulp.

3. A method as claimed in claim 2, c h a r a c t e r i z e d in that the enzyme is added to the white water in a wire well (2) into which the white water drained from the forming sheet is collected.

4. A method as claimed in claim 1, c h a r a c t e r i z e d in that the enzyme is added to the long circulation of the paper machine in a couch pit (16) into which the white water drained by suction from the forming sheet is collected.

5. A method as claimed in any of the foregoing claims, c h a r a c t e r i z e d in that the enzyme is added to white water having a maximum fiber consistency of approx. 0.4 %.

6. A method as claimed in any of the foregoing claims, c h a r a c t e r i z e d in that the enzyme is added by 0.01...1 l/m³ of white water.

7. A method as claimed in any of the foregoing claims, c h a r a c t e r i z e d in that the enzyme is hemicellulase, cellulase, esterase, pectinase or a combined mixture of these.

8. A method as claimed in any of the foregoing claims, c h a r a c t e r i z e d in that the pulp used in the process is a mechanical pulp such TMP.

9. Use of an enzyme for disintegrating organic matter dissolved or dispersed from the pulp into the white water of the paper machine.

10. Use of hemicellulase, cellulase, esterase, pectinase or a combined mixture thereof in accordance with claim 9 for disintegrating organic matter dissolved or dispersed from the pulp into the white water of the paper machine.

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